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Hofbaüer

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[54] **DISCHARGE ARRANGEMENT FOR THE EXHAUST GAS FROM THE WORK AREAS OF A ROTARY PISTON COMBUSTION ENGINE**

[75] Inventor: **Peter Hofbaüer**, Wolfsburg, Germany

[73] Assignee: **Volkswagenwerk Aktiengesellschaft**, Wolfsburg, Germany

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[63] Continuation of Ser. No. 299,594, Oct. 20, 1972, abandoned.

[52] **U.S. Cl.** ..... **418/61 B**; 418/94; 418/144; 418/186; 123/8.45

[51] **Int. Cl.** **F01c 1/02**; F01c 21/04; F02b 55/16

[58] **Field of Search** ..... 418/61 B, 94, 144, 183, 418/186–188; 123/8.45

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Primary Examiner—John J. Vrablik
Attorney, Agent, or Firm—Ernest F. Marmorek

[57] **ABSTRACT**

A combustion engine of the circularly rotating piston type having an internally placed axle and a housing having at least a pair of side members and a central member, a piston mounted for rotation on an eccentric shaft and having a profile including 2 N lobes defined by an epitrochoid curve, the central member having an inner profile having 2 N + 1 counter lobes forming an outer envelope curve for the piston, gas outlet control openings provided in the circumferential surface of N lobes of the piston, outlet passages provided in a side portion of the piston, an exhaust gas outlet provided in one of the side members and cooperating with the outlet passages in the piston for leading away the exhaust gas from the operating spaces and the piston, a first radial outer sealing strip for sealing the operating spaces forming between the piston and the contour of the central member of the housing and a second radial inner sealing strip for sealing the bearing points of the piston on the excentric shaft which are lubricated by a lubricating means, the outlet opening formed on one of the side portions of the piston lying in a region defined by an envelope curve generated during rotation of the piston by the inner contour of the first radial outer sealing strip as projected on the piston and by the outer contour of the second radial inner sealing strip.

6 Claims, 4 Drawing Figures

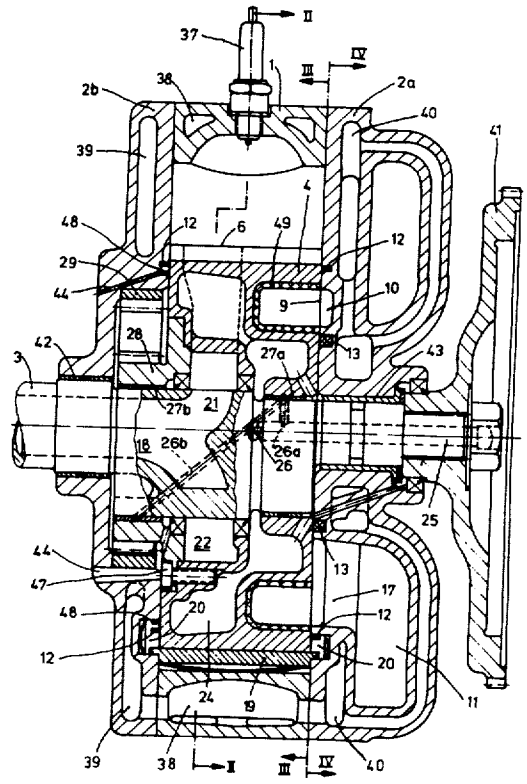


Fig.1

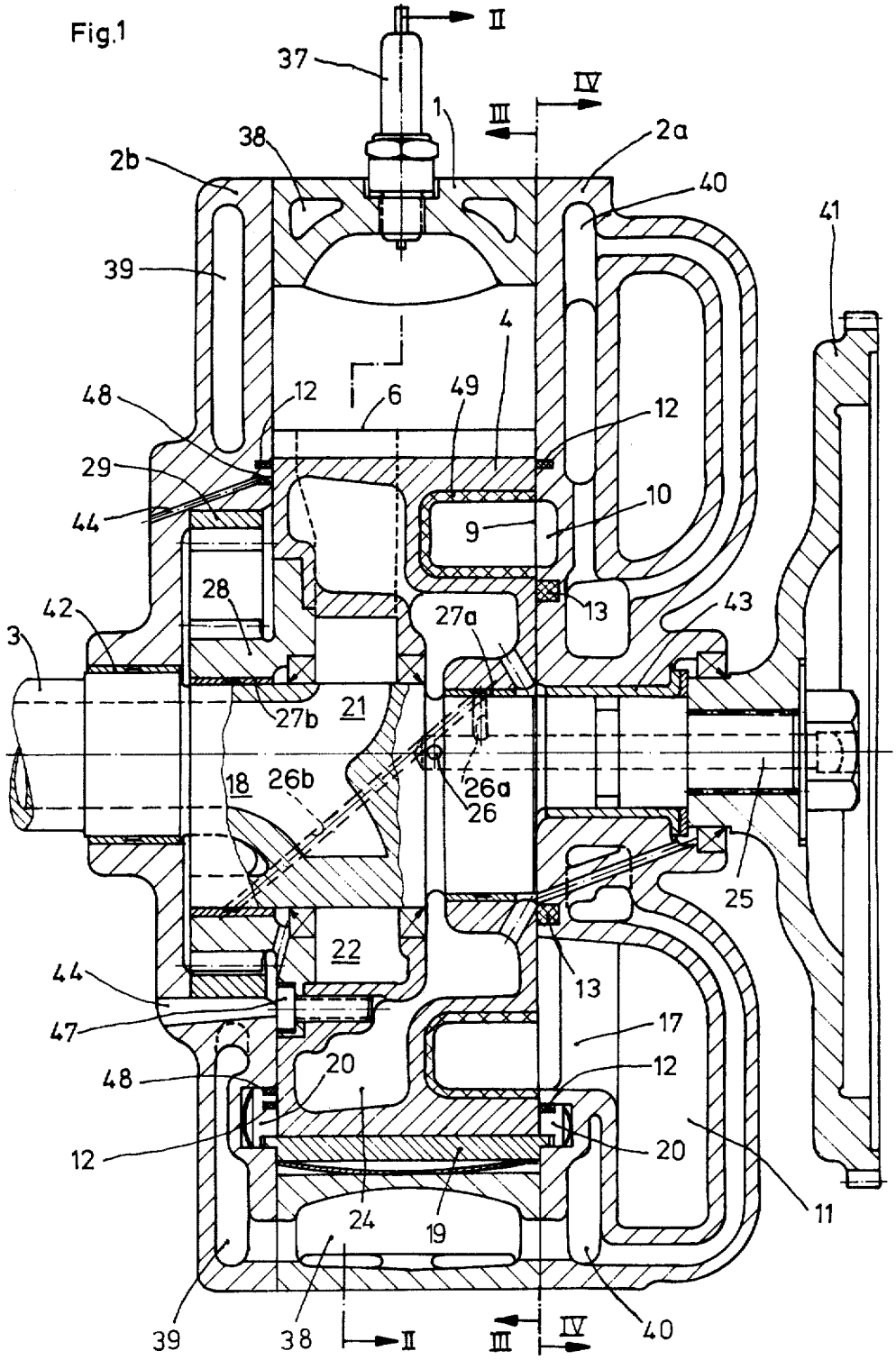
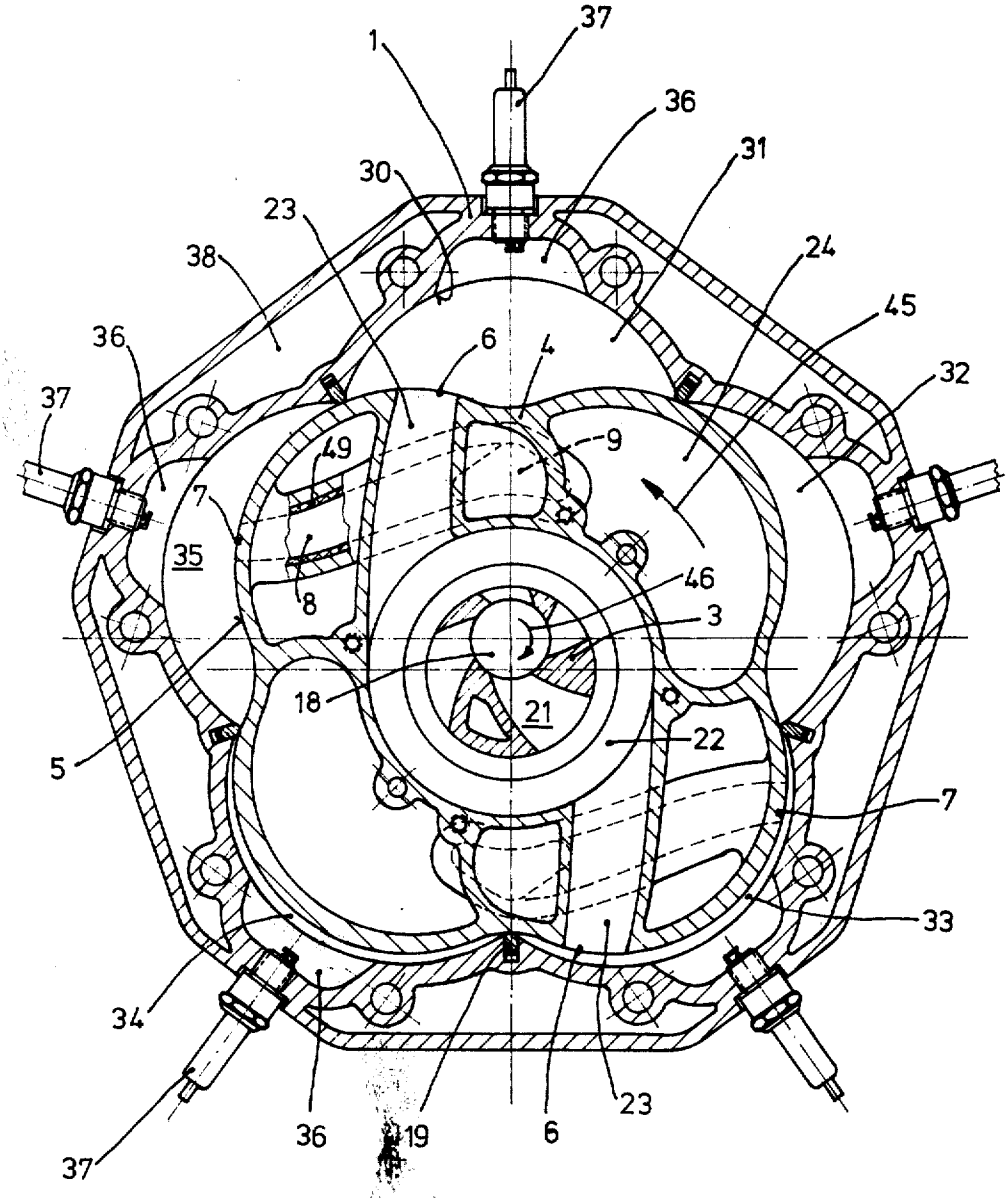

II
37
IV
1
III
2a
38
2b
40
41
39
4
48
12
6
49
12
29
10
44
9
28
42
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27a
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27b
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26b
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Fig.2


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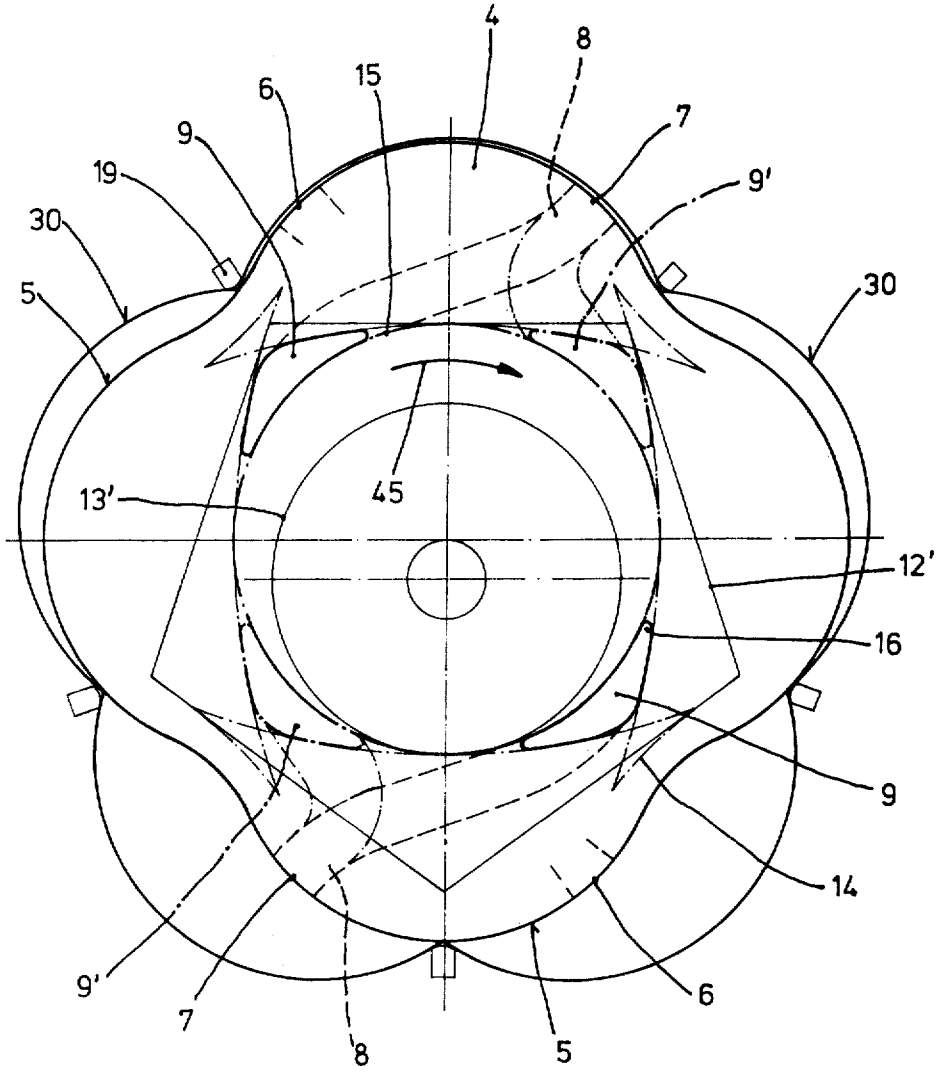
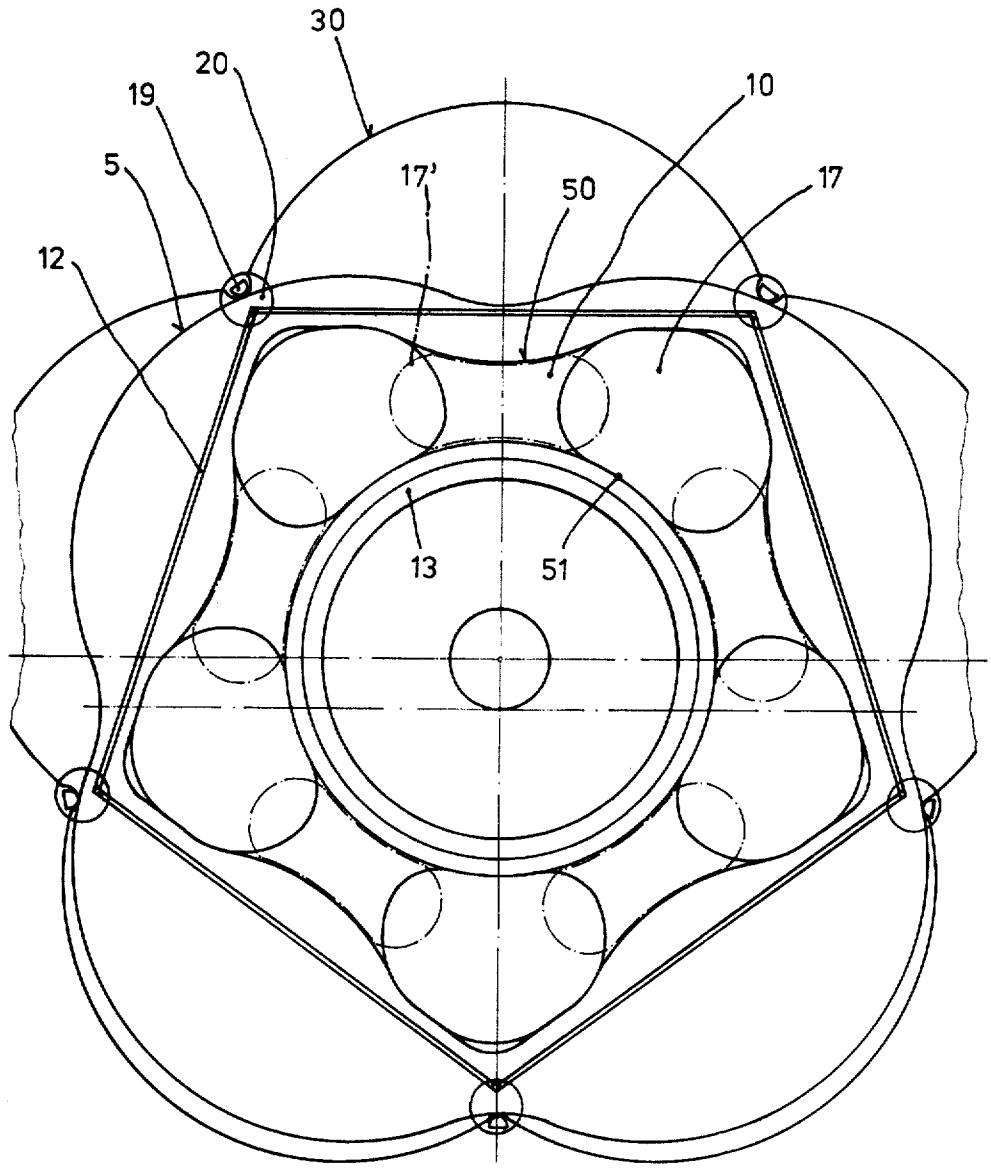


Fig.3

Fig.4



DISCHARGE ARRANGEMENT FOR THE EXHAUST GAS FROM THE WORK AREAS OF A ROTARY PISTON COMBUSTION ENGINE

This is a continuation of application Ser. No. 299,594, filed Oct. 20, 1972 and now abandoned.

FIELD OF THE INVENTION

The present invention relates generally to a combustion engine having a circular piston arrangement, an internal axle, a camming contact in which the piston is mounted on an eccentric shaft and rotates in a housing comprising at least a pair of side members and a central member, the latter comprising outer portions defining a curved internal space and sealing means describing during rotation a predetermined curve.

More particularly, the present invention relates to a combustion engine having a circular piston arrangement therein, in which the profile of the piston comprises 2 N lobes defining an epitrochoid curve and, accordingly, the housing profile defines 2 N + 1 counter lobes as an envelope curve for the piston and, in which on the peripheral surfaces of N lobes of the piston there are provided gas exhaust openings which terminate through an exhaust passage provided in the piston and through exhaust gas openings in a side member of the housing, in an exhaust conduit. The combustion engine according to the present invention includes also sealing means provided in the side members of the housing of which a first sealing means is a radial outer sealing means serving for the sealing of the operating spaces formed between the piston and the housing, whereas a second radial inner sealing means serves for the sealing of the bearing points of the piston on the eccentric shaft which is supplied with a lubricant.

BACKGROUND OF THE INVENTION

Research efforts in recent years performed on combustion engines were concentrated mainly on the attempt to reduce the contaminating components in the exhaust gas or completely eliminate them. This can be attained by the improvement of the combustion process occurring with the combustion engine or by the provision of devices, such as, catalyzators which are connected after the combustion spaces and which are intended for the cleaning of the exhaust gas from its contaminating components.

With respect to the creating of an environment for a good and complete combustion of the gases in the combustion spaces, the combustion engines having a rotary-type piston arrangement appeared to be the most promising devices, since the combustion spaces can be made to have any desirable shape. This is especially true for the combustion engines having a circular-type piston arrangement therein, as mentioned above, and which are characterized by a camming contact and by an outer envelope of the inner space and of the piston. This type of combustion engines is one of the several constructional possibilities of the circular piston engines which have been described and grouped according to their characteristic differences in the book "The Types of Combustion Engines Having Rotary-Type Pistons" of Felix Wankel, published by the Verlag Anstalt GmbH, in 1963.

During the development of a combustion engine having a rotary-type piston arrangement, a camming contact and an outer envelope shape therein, there have been considerable difficulties encountered especially in its application to the desirable four-cycle process. So far it has been believed that — in order that a four-cycle process could be performed — there is a necessity for plate valves, rotating sliding valves or side discs which are carried along with the piston, so that a satisfactory gas exchange could take place. Such elements, however, would require considerable space and special construction and, in several respects, would lead to considerable difficulties.

For more details of a related and background invention, reference should be had to the co-pending application of Peter Hofbauer et al., filed Oct. 18, 1971 under Ser. No. 190,196 and assigned to the assignee of the present invention.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a combustion engine having a rotary-type piston arrangement therein, as mentioned above, in which the four-cycle process can be satisfactorily performed without any major constructional provisions and, which is provided with a special means for the leading away of the hot exhaust gases.

It is a more specific object of the present invention to provide the combustion engine of the above-mentioned type, in which the arrangement of the exhaust gas openings in the piston and of the exhaust gas output channels corresponding to such exhaust gas openings are preferably provided in a side portion of the housing.

According to the present invention, on a side front surface of the piston, exhaust openings are provided within a region which is defined by the inner contour of a first radial outer sealing means projected onto the piston by the generation of its envelope curve during the rotation of the piston and by the same of the outer contour of the second radial inner sealing means. The exhaust openings according to the present invention have a triangular shape, wherein the corners of the triangle are rounded off.

In a further embodiment according to the present invention, the exhaust gas openings can be connected with each other by an exhaust gas guide slot running substantially circumferentially and provided in a side member of the housing. The exhaust gas guide slot under these conditions obviously must be falling within the region limited by the above-mentioned two envelope curves.

According to a still further aspect of the present invention and, as a result of the last-mentioned requirement, the radial inner and outer walls of the exhaust gas guiding slots on the side member are defined by the envelope curves generated during the rotation of the piston by the contours of the outlet openings in the side of the piston and projected on the side member.

According to still another aspect of the present invention, the connecting channels provided in the side portion of the housing, and serving for the connecting of the exhaust gas slots, are coupled with an exhaust gas conduit leading to the outside. As a result, the connecting channels can be provided in the corners of the exhaust gas guide slots where the exhaust gas openings during the rotation of the piston have their translatory speed reduced and perform a rotational movement about a pole which lies very close to this time instant. It is also possible that the connecting channels are pro-

vided in the middle portion between two corners of the exhaust gas guide slot.

The above measures can be equally well applied to a combustion engine having a single piston or to a combustion engine having several pistons and in each case one will attain a good exhaust of the gases at a minimum heating of the components of the engine and, at the same time, an excellent possibility is created for connecting the exhaust gas conduit leading to the outside or for the connection of an after burner apparatus for being coupled after the combustion spaces. The earlier assumption of the experts that a combustion engine having a circular-type piston arrangement therein with a camming contact and an outer envelope curve shape, must have a special rotary slider valve for the control of the gas exchange and, especially for the controlling of the exhaust gases, turned out to be incorrect. It has been found that it is essential that the gap remaining between the piston and the housing in a corresponding position of the piston must prevent a flow between input and output of the gases.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will become more readily apparent from the following description of a preferred embodiment thereof shown, by way of example, in the accompanying drawings, in which:

FIG. **1**, is a longitudinal section through a combustion engine having a circular-type rotary piston arrangement therein and being of the construction type designated by Ka **5** : **4**;

FIG. **2** is a cross section through the illustration of FIG. **1** along the section line II—II;

FIG. **3** is a schematic representation of the gas exhaust openings on the front surface of the piston lying in the plane along the line III—III in FIG. **1**; and

FIG. **4** is a view similar to FIG. **3**, illustrating the gas guiding slots on the side member of the housing along the line IV—IV in FIG. **1**.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The combustion engine having a rotary circular piston arrangement therein, as illustrated in FIGS. **1** and **2** of the drawings, is of the constructional type Ka **5** : **4** and includes a piston means **4** slidably mounted on an eccentric shaft **3** and arranged to rotate thereon within a housing comprising a central peripheral member **1** and a pair of side members **2***a* and **2***b*. The piston means **4** has a toothed pinion **28** secured thereto by bolts **47**; said pinion **28** cooperates with an internally toothed wheel **29** secured to the stationary housing and establishes a camming contact for the piston with the side members **2***a*, **2***b* and defines its path of rotation.

The circumferential profile of the piston means **4** is defined by an epitrochoid **5** and, at the given translating ratio of 5:4, has four lobes. The inner contour **30** of the central peripheral member **1** of the housing is in the form of an outer envelope curve for the epitrochoid **5**. The internal contour **30** of the central member **1** of the housing having been defined in such a manner, together with the outer peripheral surface **5** of the piston means **4** creates five operating spaces **31** – **35** which, in turn, communicate each with a combustion space **36** into which a sparkplug **37** terminates.

In the side members **2***a* and **2***b*, as well as in the central member **1** of the housing of the circular piston arrangement of the combustion engine, cooling spaces **38**, **39** and **40** are provided which are interconnected and are flushed by an appropriate cooling medium, such as water.

In order to supply the operating spaces **31** – **35** with the fresh gas mixture for the combustion, the eccentric shaft **3** is provided for this purpose with a bore **18** in the center thereof. Said central bore **18** communicates over transversely shaped passages **21** with an annular channel **22** provided in the piston means **4**, wherefrom then the mixture will reach over the fresh gas channels **23** the input control apertures **6** provided on the periphery of the piston means **4**. These input control apertures **6** are provided on one half of the lobes of the piston profile **5**. In the illustrated embodiment, for instance, they appear on a pair of oppositely lying lobes of the piston profile **5**. On the same lobes of the piston profile **5** where the openings **6** are provided, there are also provided exhaust control apertures **7** which communicate over the exhaust channels **8** provided in the piston means **4** with exhaust apertures **9** provided in a side frontal surface of the piston means **4**, as hereinafter described in more detail. The exhaust openings **9** terminate in an exhaust gas guide slot **10** running substantially circumferentially in the side member **2***a* of the housing. The exhaust guide slot **10** communicates over connecting channels **17** with an exhaust gas conduit **11** leading to the atmosphere.

The sealing elements in the illustrated embodiment are provided on the stationary housing and comprise a radial sealing strip **19** which is under spring pressure and is seated in a goove on the central member **1** and extends axially over the entire width of the piston means **4**, as well as an axial sealing strip **12** which is placed in appropriate grooves in the side members **2***a* and **2***b* of the housing. In order to attain a closed sealing boundary, corner sealing means **20** are provided in the side members **2***a* and **2***b* of the housing and into which an end portion of the radial strips **19**, as well as the corners of the axial sealing strips **12**, arranged in the form of a pentagon, terminate. The sealing off of the bearing points **27***a* and **27***b* of the piston means **4** which are lubricated by a lubricant through a central opening in the shaft **25** and through transverse openings **26***a* and **26***b*, is arranged by means of circular or annular sealing elements **13** provided in the housing side member **2***a* and by sealing elements **48** provided in the housing side member **2***b*.

A transverse bore **26***a* fluidly communicates the central opening **25** with the bearing point **27***a* and a second supply core **26***b* extends from the first bearing point **27***a* through the eccentric shaft **3** to the second bearing point **27***b* so that both bearing points **27***a* and **27** *b* are supplied with lubricating oil.

Inside the piston means **4** there are provided hollow spaces **24** which communicate with the bearing points **27***a* and **27***b* thereby receive oil therefrom for the cooling of the piston walls. The used oil flows through outputs **44** provided in the housing side member **2***b* into a waste oil collector, not shown in the drawings.

The eccentric shaft **3** is journaled in the housing portions **2***a* and **2***b* by means of bearings **42** and **43**, and at its driving side is provided with a flywheel **41**.

In the following the operation of a four-cycle combustion engine having a circular-type piston arrangement therein will be described in more detail:

As can be seen in FIG. 2, the piston means 4 in its illustrated position has reached substantially its upper dead center position in the operating space 34. Prior to this position, the piston means 4 has compressed the mixture so that now in the operating space 34 the combustion can take place, during which the sparkplug 37 will ignite the mixture compressed in the combustion space 36 of the operating space 34. During the subsequent combustion, the expanding combustion gases push the piston means 4 in the direction of rotation indicated by the arrow 45, whereupon the eccentric shaft 3 will be driven in the direction of the arrow 46. The expansion stroke will end at the instant when the operating space 34 attains its largest volume. In about this state is also the operating space 32 which, during the further rotation of the piston means 4, becomes connected with the exhaust control opening 7. At this instant the exhaust stroke starts during which the burnt gas leaves through the exhaust control opening 7 and the exhaust gas channel 8 toward the exhaust aperture 9 which communicates with the gas guiding slot 10 provided in the housing side member 2*a*. Said exhaust stroke is performed by the piston 4 in its position illustrated in FIG. 2 also for the operating space 35.

Upon completion of the exhaust stroke in the respective operating spaces, the piston 4 will reach there its upper dead center again during which the volume enclosed by the housing contour 30 and the piston profile 5 becomes a minimum. Adjoining this state, which is illustrated in FIG. 2 by the operating space 33, there follows next an intake stroke during which fresh mixture is let in into the gradually increasing operating space 33 through the input control opening 6. (Compare the position of the operating space 31). In the above-described manner, an intake, compression, combustion with expansion and an exhaust stroke will take place for each operating space 31 – 35 in a four-cycle process consecutively. Thus during a rotation of the piston means 4 there will take place ten ignitions in the operating spaces 31 – 35, that is, in each operating space there will occur two completed, closed operating periods or cycles.

In order that the exhaust gases could be led away in a satisfactory manner, the gas outlet apertures 9 are provided on a frontal surface of the piston means 4 in a special manner. Such arrangement of the apertures 9 can be observed in more detail in FIG. 3. Here the piston means 4 is represented only the profile curve which the epitrochoid 5 describes, while the central member 1 of the housing is represented only by the envelope curve 30 thereof. The piston means 4 when compared with the same of FIG. 2, is in a somewhat different position; more particularly, it is shown in a position at which the piston in the upper operating space 31 has reached the upper dead center point after completing the exhaust stroke.

Next to the illustrated input control aperture 6 on the peripheral surface of the piston means 4 there are also shown outlet control openings 7 which over the outlet channel 8 communicate with the outlet apertures 9. On the piston front surface in FIG. 3 there is shown the projection 12′ of the radial inner contour of the axial sealing strip 12 assembled in the shape of a pentagon and, by 13′ the projection of the radial outer contour of the ring-like sealing means 13 is illustrated as a projection on the side of the piston. Such sealing means 12 and 13 are provided on the side members as can be seen from the showing of FIG. 1 and as has already been mentioned above. When the piston 4 rotates, the contours of said sealing means 12 and 13 generate a so-called envelope curve, as indicated by the dash-and-dot lines 14 and 15, of which the curve 14 is the generated envelope curve of the inner contour 12′ of the axial sealing strip 12 formed as a pentagon, while the curve 15 is the generated envelope curve of the outer contour 13′ of the sealing element 13. The generated envelope curves enclose in the vicinity of the piston profile adjacent the axle or shaft 3, a triangularly shaped region where, according to the present invention, the outlet apertures 9 are arranged which are in communication with the outlet controlling apertures 7 over the outlet channels 8. As can be seen more clearly from FIG. 3, for each outlet controlling aperture 7 there are possible two different outlet apertures 9 or 9′. The outlet apertures identified by 9′ have a relatively short outlet channel 8 which results in a quick delivery away of the hot combustion gases and thereby a relatively low heat loading for the piston means 4. For this purpose also the outlet channels 8 are provided with a heat insulation 49, as can be seen in FIG. 2. It would also be possible to subdivide the outlet controlling passage 7 and one of such subdivided portion to connect with the outlet aperture 9, while the other portion could be connected with the outlet aperture 9′.

FIG. 4 illustrates the construction of the gas guiding slot 10 provided in the side member 2*a* of the housing. The gas guiding slot 10 is constructed in such a manner that the contours 50 of the radially outer-lying wall thereof and the contour 51 of the radially inner-lying wall thereof are shaped as the generated envelope curves of the contours of the outlet apertures 9 as projected onto the side of the side member 2*a* of the housing. By the formation of the gas guiding slot 10 in such a manner, it is assured that in each position of the piston means 4 the gas outlet aperture 9 terminates completely into the gas guiding slot 10 on the side member 2*a* of the housing and reliably leads away the exhaust gases.

With further reference to FIG. 4 in which the piston 4 itself is represented only by its contour 5 and the central member 1 of the housing of the circular-piston combustion engine is represented only by its contour 30, one can observe the arrangement of the connecting channels 17 which serve for connecting the gas guiding slot 10 with the exhaust conduit 11 leading to the outside. According to the present invention, the connecting channels 17 can be provided in the region of the corners of the pentagon-shaped figure formed by the axial sealing strip 12. In said corners the outlet apertures 9 undergo a reduction of their translatory speed during the rotation of the piston 4 with respect to the side member 2*a* of the housing and undergo only a rotational movement about a pole which lies very near to this time instant. Under the expression "pole" one should understand a point about which all points of the piston rotate. The movement of the piston 4 at each instant represents a rotation about a point, the so-called pole, which is formed by the rolling point of the toothed wheels 28 and 29 which are in contact. Another possibility indicated by the dash-and-dot line 17′ in FIG. 4 resides in that the connecting channels in the middle portion between two adjacent corners of the pentagon are formed by the sealing strip 12. Such arrangement of the connecting channels 17′ is preferable

under conditions when the outlet apertures on the front surface of the piston **4** are arranged in the position indicated by the reference numeral **9'**. By such relative arrangement of the outlet apertures and the connecting channels one will attain that the outlet apertures **9'** in the piston **4** will lie opposite to a connecting channel **17'** in the gas guiding slot **10** at an instant when the outlet control passage **7** on the outer periphery of the piston **4** just passed over a radial sealing strip **19** and starts the exhaust stroke in one of the operating spaces **31** - **35**. The exhaust gas present in the particular operating space at this moment and waiting to be led away, is under high pressure and flows therefore at high velocity out of the operating space and requires that it be led away by the most direct path to the exhaust gas conduit.

I wish it to be understood that I do not desire to be limited to the exact details of construction shown and described, for obvious modifications will occur to a person skilled in the art.

Having thus described the invention, what I claim as new and desire to be secured by Letters Patent, is as follows:

1. A combustion engine of the circularly rotating piston type having an internally placed axle comprising a housing having at least a pair of side members and a central member placed between said side members, an eccentric shaft means, a piston means mounted for rotation on said eccentric shaft means with bearing points therebetween, said piston means having a front surface including exhaust gas openings that are in opposition to one of said side members and outlet channels that have a substantially uniform cross-section and are in fluid communication with said exhaust gas openings, said piston means being further defined by a profile including 2 N lobes defined by an epitrochoid curve, said central member comprising an inner profile having 2 N + 1 counter lobes forming an outer envelope curve for said piston means, gas outlet control opening means provided in the circumferential surface of N lobes of said piston means and in fluid communication with said outlet channels in said piston means, an annular exhaust gas guide means provided in one of said side members and cooperating with said outlet channels, said gas outlet control opening means and said exhaust gas openings in said piston means for leading away said exhaust gas from said operating spaces and said piston means, sealing means in said side members comprising a first outer sealing means for sealing the operating spaces between the piston means and the contour of said central member of said housing and, second radial inner sealing means for sealing the bearing points of said piston means on said eccentric shaft means, means for lubricating said bearing points, said exhaust openings formed on one said side portions of the piston means lying in a region defined by an envelope curve generated during rotation of said piston means by the inner contour of said first radial outer sealing strip means as projected on said piston means and by the outer contour of said second radial inner sealing strip means, said exhaust openings having a triangular shape, said exhaust gas guide means provided in said one side member of said housing running substantially circumferentially and permanently communicating with said exhaust openings to prevent the formation of stagnant exhaust gas pockets in said exhaust gas openings.

2. The combustion engine as claimed in claim **1**, wherein the corners of said triangularly shaped exhaust opening are rounded.

3. The combustion engine as claimed in claim **1**, wherein said exhaust gas guide means comprises radially inner and radially outer lying walls, said radially inner and radially outer lying walls being defined as the projection of the generated envelope curves of the contours of said exhaust gas guide means on the side member of the housing during rotation of said piston means.

4. The combustion engine as claimed in claim **3**, wherein said side member of said housing comprises connectig channel means for connecting the exhaust gas guiding means with an exhaust gas conduit means leading to the outside.

5. The combustion engine as claimed in claim **4**, wherein said connecting channel means are provided in the region of the corners of a polygon shape formed by the arrangement of said radial outer sealing strip means.

6. The combustion engine as claimed in claim **5**, wherein said connecting channel means are provided in the middle region between adjacent corners of a polygon formed by the arrangment of the radial outer sealing strip means.

* * * * *